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ORIGINAL ARTICLE

Utilising snake rescue data to understand snake–human conflict in Hooghly, West Bengal, India

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Background: Snakebite envenoming, classified as a neglected tropical disease, poses a significant threat to life in India, where it is estimated to cause 58 000 fatalities as well as 140 000 morbidities annually. To reduce the occurrence of snakebite, we need a comprehensive understanding of human–snake conflict ecology. Snake rescue networks represent a vital resource for gathering such ecological data.

Methods: In this study, we utilised snake rescue data from 520 rescue encounters carried out by a local rescue network in Hooghly, West Bengal, from July 2020 to October 2022, to investigate patterns of human–snake conflict and the influence of climatic factors on these patterns.

Results: The spectacled cobra *Naja naja* was the most encountered of the five venomous species involved in 365 rescues. Our analysis revealed a significant correlation between rescue location and venomous/non-venomous encounters, with non-venomous encounters being more prevalent inside built-up locations. Rainfall on the previous day significantly increased encounters and influenced the species involved, while daily minimum temperature also influenced encounters with venomous species. We also found that both *Bungarus* (krait) species present were mostly encountered between 18:00 h and midnight.

Conclusions: This study highlights the multifaceted factors influencing human-snake conflicts in the region, including seasonality, geographic location, rainfall patterns, and temperature dynamics. It underscores the potential of snake rescue data as a valuable resource for deepening our understanding of regional variations in snake–human interactions.

Keywords: climate effects, ecology, EpiCollect5, snake rescue networks, snakebite mitigation

Introduction

Snakebite envenoming is a neglected tropical disease and a public health problem that affects >2.5 million people globally.[1] India has the unenviable reputation of being called the ‘snakebite capital’ of the world, with approximately one-half of the global deaths due to snakebite occurring there.[2] A study based on hospital data showed that in India snakebite accounts for 58 000 deaths and 140 000 morbidities.[2] There have been significant research efforts in India on the venom and antivenom of medically significant snakes, the effective treatment of bites, as well as the demography of and situations in which bites occur.[2,3] However, the ecology of snake–human conflicts in India is still poorly understood,[3–5] despite the fact that the overlap between snake ecology and human activities can be crucial for understanding the context of snake–human conflict.[6–8]

Studies have attempted to explain the bite data from specific regions (e.g. via hospital admissions) in terms of both social and environmental variables.[9–12] Other studies have statistically correlated bite data to snake activity or snake distributional data.[7,13–15] A recent example is the study by Goldstein et al.,[7] who developed a simulation model that combined human agricultural activities, snake activities and climatic variations to predict the observed seasonal snakebite patterns in Sri Lanka. However, these studies use historical distribution records of different snake species[4,16] and, to date, none have incorporated actual records of snake–human conflict as it occurs on a daily basis on the ground.

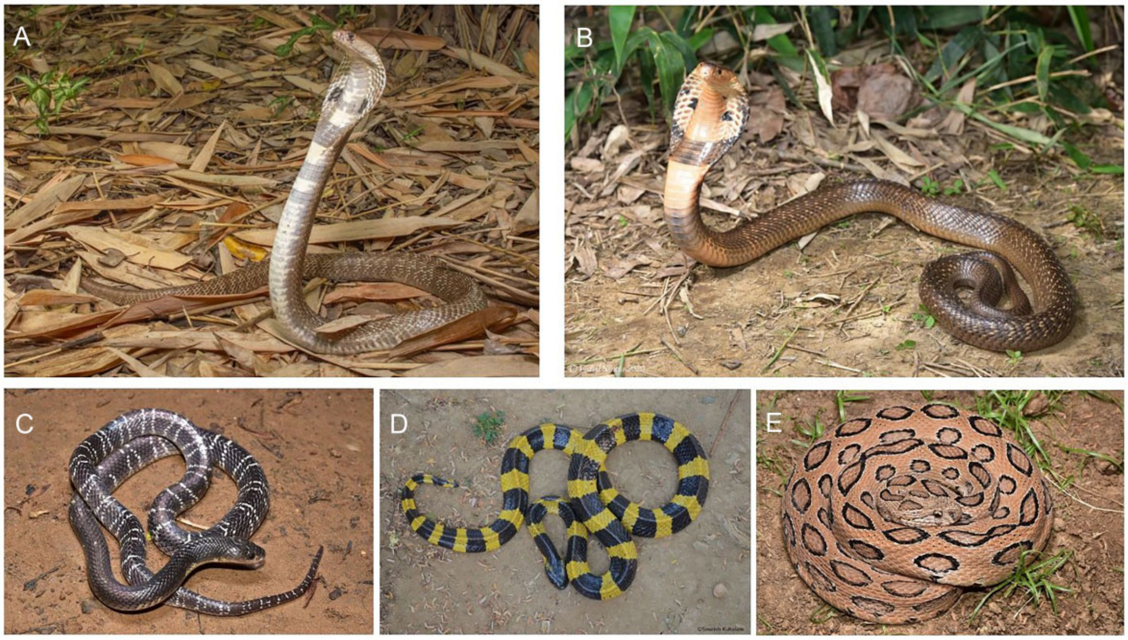


Figure 1. Images of the venomous species that were rescued in Hooghly District, West Bengal, from July 2020 to October 2022. A: *Naja naja*; B: *Naja kaouthia*; C: *Bungarus caeruleus*; D: *Bungarus fasciatus*; E: *Daboia russelii*. Photo Credits: A: J.B. Owens; B, C, E: V. Santra; D: S. Kuttalam.

In India, there are numerous snake rescue networks and independent rescuers that conduct snake rescues in their respective regions of the country,[4,17,18] which presents an opportunity to collect snake–human conflict data via snake rescue encounters.[3,19] A rescue encounter is when someone from the public encounters a snake and calls a trained professional to mitigate the conflict by removing the snake from the conflict situation. A rescue encounter, in the context of venomous snake–human conflict, is essentially a 'mitigated' snakebite envenoming scenario. Hence, such rescues can also provide invaluable information regarding the dynamics of the conflict, including information on the different snake species involved, their sex, age and size, as well as the habitat characteristics of encounters, and the date and time when each conflict occurred.[20–24]

The current study aimed to utilise such a rescue network set up by a not-for-profit organisation based in the Hooghly district, West Bengal. The main objectives were to look at patterns of snake–human conflict based on rescue encounters and whether environmental factors could play a role in influencing these patterns.

Methods

Study site

The study was undertaken in the district of Hooghly, West Bengal. Hooghly is part of the lower Gangetic Delta and borders the eastern margin of the Hooghly River.[25] The population is made up of mainly rural agrarian communities. The residential and built-up areas of the villages form 'islands' surrounded by agricultural fields of varying sizes.[4] These fields have seasonal changes in the crop cultivated and include rice, corn, jute, potato, eggplant, bamboo, various types of gourds and beans.[26]

Venomous snake species of the region

The venomous snakes present in the district are *Naja naja* (spectacled cobra), *Naja kaouthia* (monocled cobra), *Bungarus caeruleus* (common Indian krait), *Bungarus fasciatus* (banded krait) and *Daboia russelii* (Russell's viper) (Figure 1). *Naja kaouthia* is the only venomous snake of the region that has been observed to display venom 'spitting' behaviour.[27] *Bungarus fasciatus* does not appear to be medically important because, unlike the other species, there are no records or any anecdotal reports of bites occurring in this district.[4]

Rescue method

The rescue encounters analysed in the current study took place from July 2020 to October 2022. The encounters were attended by the Society for Nature Conservation, Research and Community Engagement (CONCERN), a licensed local conservation not-for-profit organisation. All rescue calls were undertaken with the permission of the West Bengal Forest Department (Permit Letter No. 04/SC/Corr./10). All the rescuers underwent 1 y of training, which covered all the skills required for snake rescues, species identification and data collection, before attending rescue call-outs. The protocol employed requires all rescue call-outs to be attended by two trained rescuers equipped with snake hooks, snake containment bags, snake bagging frame and a torch and wearing appropriate clothing, including covered shoes and full-length trousers. Rescues should not be carried out if under the influence of any substance, or when experiencing lack of sleep or ill health. Along with capture of the snake, the rescuers were also trained to educate the local villagers regarding snakebite prevention, distinguishing between venomous and similar non-venomous species, carrying out appropriate first aid for snakebite and how to access appropriate medical care.

Data collection

Once a rescue encounter was completed, data regarding the encounter were collected using an offline free-to-use data collection mobile phone application, Epicollect5 (https://five.epicollect.net/, University of Oxford, Headington OX3 7LF, United Kingdom), for the generation of forms (questionnaires) and freely hosted project websites for data collection. The rescuer completed a data form on this application, which also included an image of the snake for species verification by Vishal Santra and Sourish Kuttalam (Supplementary Table 1), and uploaded the data to an Epicollect5 server. All data forms were subsequently collated and downloaded for analysis.

Climate data for the region during the same time period were provided by the Indian Meteorological Department (IMD; https://dsp.imdpune.gov.in/) and included the daily minimum temperature, daily maximum temperature and the daily humidity.

Statistical analysis

The affected stakeholders' primary concern in the case of an encounter with a snake is whether the snake is venomous or not, hence we compared encounters involving venomous and non-venomous species.

χ^2 goodness-of-fit tests were conducted to examine whether the observed distribution of venomous and non-venomous rescue encounters across different sites significantly deviated from the expected distribution, assuming an equal probability of encountering a venomous or non-venomous snake at each site. The sites were grouped into inside or outside sites based on whether they are sites within enclosed built-up sites (i.e. bathroom, bedroom, bird enclosure, courtyard, kitchen, shop, store room) or outside enclosed built-up areas (i.e. agricultural field, backyard/front garden, cow shed, water body). A Pearson's χ^2 test for independence was performed to test for an association between the type of snake rescued (venomous or non-venomous) and the location of the rescue encounters (inside or outside).

We also tested for an association between the location of the rescue encounters and rain on the day of the encounters for both venomous and non-venomous groups using a Pearson's χ^2 test for independence. To further understand the influence of rain on human–snake conflict, different combinations of consecutive dry and rain days were tested to see if this influenced the likelihood of a rescue encounter occurring. Each day of the study period was categorised as (i) dry: dry (for a dry day that was preceded by a dry day); (ii) dry: rain (for a rain day that was preceded by a dry day); (iii) rain: dry (for a dry day that was preceded by a rain day); or (iv) rain: rain (for a rain day that was preceded by a rain day). These day combinations were compared with each other to test for a significant association between the day combination type and a rescue occurring using a Pearson's χ^2 test.

Species with a minimum of 15 rescue encounters were selected to test for differences in the time of day of the rescue encounters and the effect of climate. We tested the differences between the time of day (i.e. early morning: 00:00:00–05:59:59; late morning: 06:00:00–11:59:59; afternoon: 12:00:00–17:59:59; evening: 18:00:00–23:59:59) on the rescue encounters of the selected species using a Pearson's χ^2 test.

Table 1. Frequency of rescues encountered by specific species in Hooghly District, West Bengal, from July 2020 to October 2022

Family	Species	Encounters
Elapidae	*Naja naja*	190
	Naja kaouthia	17
	Bungarus caeruleus	38
	Bungarus fasciatus	42
Viperidae	*Daboia russelii*	78
Colubridae	*Argyrogena fasciolatus*	1
	Dendrelaphis tristis	17
	Dendrelaphis proarchos	1
	Boiga trigonata	2
	Oligodon arnensis	4
	Ptyas mucosa	48
	Ahaetulla oxyrhyncha	4
	Lycodon aulicus	37
	Lycodon jara	3
Natricinae	*Fowlea piscator*	28
	Amphiesma stolatum	2
Homalopsidae	*Enhydris endhydris*	3
Boidae	*Eryx conicus*	1
	Eryx johnii	1
Typhlopidae	*Argyrophis diardii*	2
	Indotyphlops braminus	1

Along with daily climate data of rain, minimum temperature and maximum temperature provided by the IMD, the daily temperature range was generated by calculating the difference between daily maximum and minimum temperatures. To determine if these climate factors varied significantly between the rescue encounters of the selected species, one-way ANOVAs were calculated for parametric data and Kruskal–Wallis tests were carried out for non-parametric data.

To test the influence of climate variables (same day rain, previous day rain, minimum temperature and maximum temperature) on the presence or absence of a rescue encounter, we created binary regression models for each selected species separately. Variance inflation factors, calculated using the 'usdm' package to check for collinearity[28] between variables, did not exceed the threshold of 5, hence all variables were used in the models. The area under the curve (AUC) for each model was also calculated to see how accurately each of the model predictions were.

All statistical analyses were performed in RStudio.[29]

Results

A total of 520 rescues were completed from July 2020 to October 2022, and five venomous and 16 non-venomous species of snakes were identified during these rescue encounters (Table 1). A total of 365 encounters involved venomous species, and a total

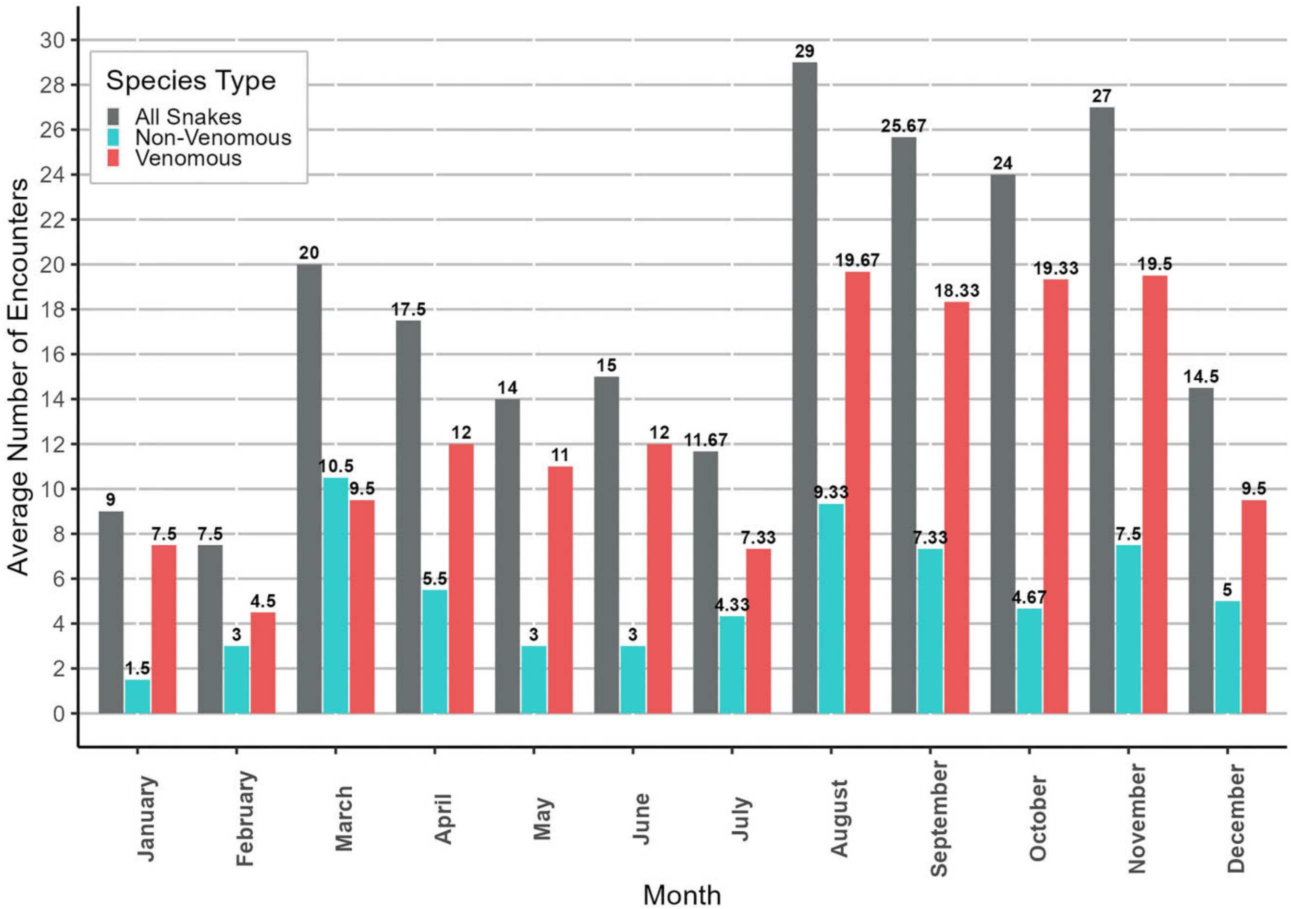


Figure 2. The average number of rescue encounters for all snake species, venomous and non-venomous snake species for each month in Hooghly District, West Bengal, from July 2020 to October 2022.

of 155 encounters involved non-venomous species. *Naja naja* was the most encountered venomous snake with 190 rescue encounters, while *Ptyas mucosa* was the most rescued non-venomous snake with 48 rescue encounters. The site with the greatest number of encounters for both venomous and non-venomous was backyard/front garden.

Seasonal patterns of rescue encounters

Overall, there was a decrease in the average rescues per day (2020: 2.05; 2021: 1.49; 2022: 1.37) over the 3 y studied. The average number of venomous rescue encounters each month exceeded the average number of non-venomous rescue encounters in each month apart from March (Figure 2). The highest average monthly number of rescue encounters for all snakes, and for venomous snakes, occurred in August, but in March for non-venomous snakes (Figure 2). Most rescue encounters for venomous snakes occurred during the second half of the southwest monsoon season (August and September) and the first half of the postmonsoon season (October and November), but a smaller increase in rescue encounters (both venomous and non-venomous species) occurred in February and March (Figure 2).

Site differences between venomous and non-venomous rescue encounters

Overall, there were more venomous snake rescue encounters at each site (Figure 3), but these were significantly different in the categories of backyard/front garden ($p<0.001$), bathroom ($p=0.004$), courtyard ($p<0.05$), kitchen ($p<0.001$), store room ($p<0.01$) and water body ($p<0.001$) (Figure 3). Only two of these sites, backyard and water body, are outside sites.

For non-venomous rescue encounters, 96 were recorded at inside sites and 57 were recorded at outside sites. For the venomous rescue encounters, 183 were recorded at inside sites and 181 were recorded at outside sites. The analysis revealed a significant association between the species type and the location of a rescue encounter ($p<0.01$), with a higher proportion of non-venomous rescue encounters occurring at inside sites (n=96, 62.7%) rather than at outside sites (n=57, 37.3%). By contrast, the proportions of venomous rescue calls occurring at inside and

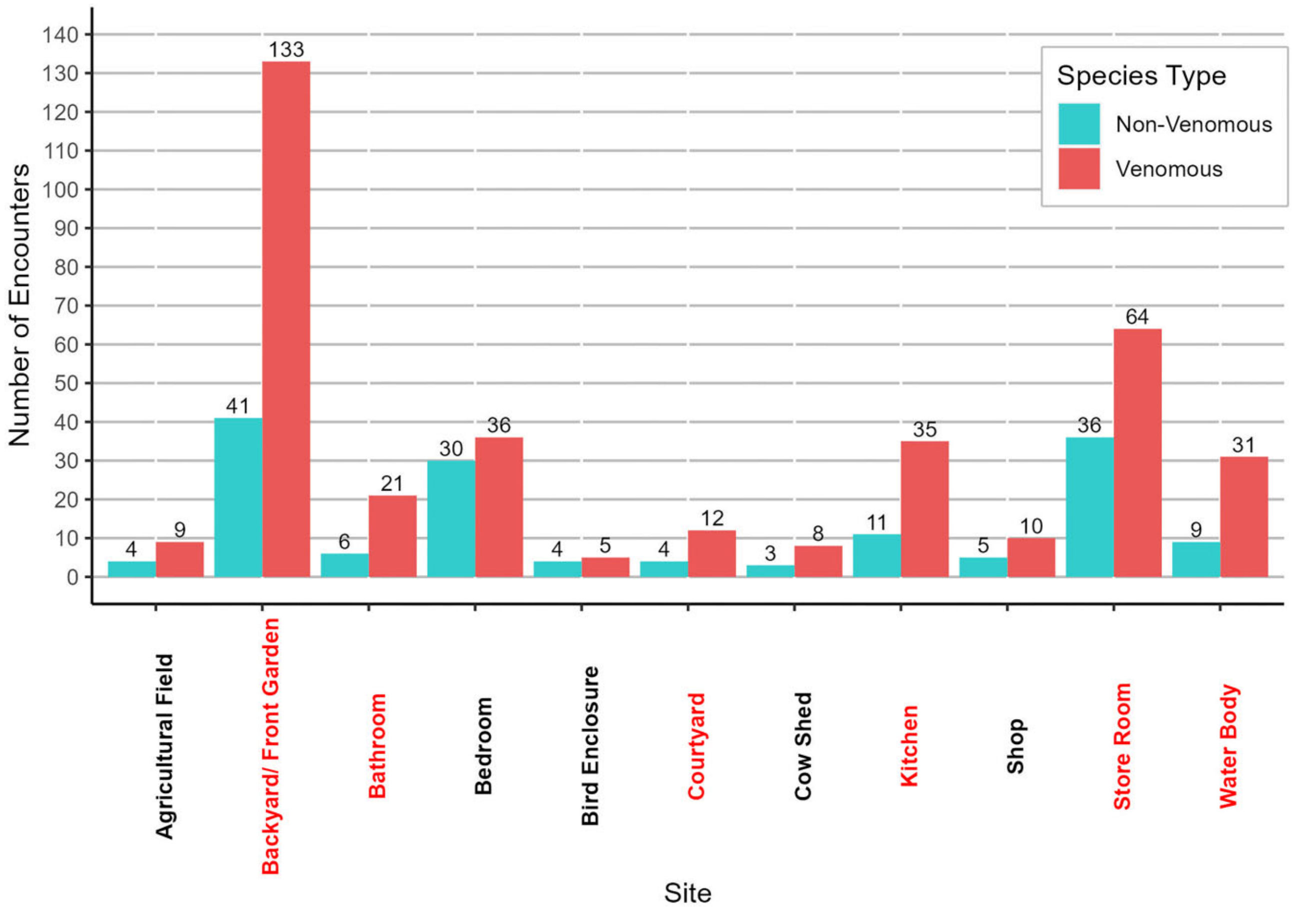


Figure 3. The number of rescue encounters from July 2020 to October 2022 for venomous and non-venomous species at each of the defined sites. Sites with χ^2 goodness-of-fit tests showing significant differences between the number of rescue encounters of each species type are shown in red.

outside sites were roughly the same (inside: n=183, 50.3%; outside: n=181, 49.7%).

Effect of climatic factors

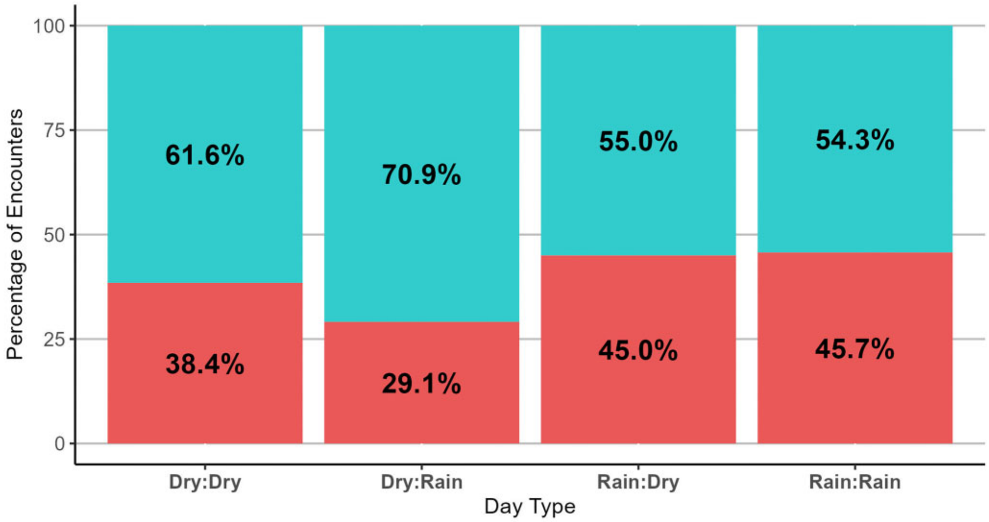
There was no significant relationship between the location of the rescue encounters (inside or outside) and the weather (dry or rain) for either venomous (dry days: inside=130 [51.4%], outside=123 [48.6%]; rain days: inside=43 [49.4%], outside=44 [50.6%]) or non-venomous rescue encounters (dry days: inside=70 [63.1%], outside=41 [36.9%]; rain days: inside=19 [57.6%], outside=14 [42.4%]). For the different combinations of day types, more rescue encounters took place on dry: rain days compared with rain: dry ($p<0.05$) and rain: rain days ($p<0.05$) (Figure 4). However, there was no significant association between the location of the rescue encounters and the day type combination.

Most rescued species comparisons

The venomous species with a minimum of 15 rescue encounters that were selected for further analysis were *B. caeruleus*, *B. fasciatus*, *D. russelii* and *N. kaouthia*, and the non-venomous species selected were *D. tristis*, *F. piscator*, *L. aulicus* and *P. mucosa*.

Because the assumption of normality was violated for all climate factors ($p<0.05$) apart from temperature range, and homogeneity of variance was violated for minimum temperature ($p<0.05$), Kruskal–Wallis tests were conducted instead of one-way ANOVAs for these climate factors. There was a statistically significant relationship between minimum temperature and encounters of different species ($p<0.001$; Figure 5). A post-hoc Dunn Test showed that *Daboia russelii* (mean=22±4.78°C) rescue encounters occurred at a significantly lower mean minimum temperature ($p<0.01$) compared with those involving *B. caeruleus* (mean=25.5±2.96°C), *B. fasciatus* (mean=25.2±2.84°C) and *N. naja* (mean=24.2±4.09°C). Rescue encounters involving *D. russelii* also took place at a significantly lower mean minimum temperature than those involving *P. mucosa* (mean=24.2±3.56°C).

Because temperature range met the assumptions of normality, homogeneity of variance and independence of observations, we carried out a one-way ANOVA, which showed that there was a statistically significant relationship between the mean daily temperature range and the rescue encounters of different species ($p=0.049$). A post-hoc Tukey HSD test showed *D. russelii*



	Dry:Dry	Dry:Rain	Rain:Dry	Rain:Rain
No	293	56	44	57
Yes	183	23	36	48

Figure 4. A stacked plot showing the proportion of days there were no rescue encounters (blue) or there was a rescue encounter (red) for each day type combination in Hooghly District, West Bengal, from July 2020 to October 2022. The table below the plot shows the number of days for the same for each day type.

(mean=9.93±3.37°C) rescue encounters occurred on days with a significantly higher temperature range ($p<0.05$) than *B. caeruleus* encounters (mean=7.79±2.56°C).

The binary logistic regression models for each of the selected species indicated that the chances of a rescue encounter were significantly associated with a climate factor only for four venomous species (Table 2). Rescue encounters for *B. fasciatus* showed a positive association with rain on the previous day, while *B. fasciatus*, *B. caeruleus* and *N. naja* encounters showed a positive association with the daily minimum temperature. All AUC scores were between 0.8 and 0.5, showing that these models were only slightly good at predicting the presence or absence of a rescue encounter of their respective species.[30]

Prior to comparing time periods of rescue encounters of the selected species, the early morning period was removed from the analysis due to the majority of the counts being 0 or <5 (Table 3). There was a significant association between the species involved in rescue encounters and the time period of those encounters ($p<0.001$); notably, among the venomous species, both *Bungarus* species were predominantly encountered during the last time period of the day (Table 3).

Discussion

Overall, the current study shows that snake rescue data help further our understanding of the snake–human conflict occurring in Hooghly district. With 21 species rescued during the study, the diversity of snake species of the region is also well accounted for. The notably higher number of venomous snake rescue encounters can potentially indicate a combination of indigenous knowledge in identifying hazardous species,[31] as well as the outreach work performed during multiple snakebite awareness campaigns over the past decade by CONCERN regarding the visual keys to identifying those species that are medically significant. During every rescue encounter, once the snake has been captured and the data collected, the rescuers usually provide information to the public present regarding methods by which residents can mitigate potential conflicts in the future. Parallel to responding to these rescue encounters, the not-for-profit organisation has also provided literature and posters to all the local schools and primary healthcare centres because snakebite prevention is better than tackling a snakebite treatment.[32] This may be reflected in the observed decrease in the average number of rescues per day across the 3 y of the study.

The rescue encounters peaked during the second half of the southwest monsoon (August and September) and in the postmonsoon season (October and November). February and March, which saw a smaller peak in rescue encounters, are also months during which the season shifts from winter to summer according to the IMD season categorisation.[33] While some clinical surveys of snakebite studies show the peak as starting earlier, coinciding with the whole duration of the monsoon period,[2,34] our study shows that human–snake conflict continues in the period following the monsoons in this region. The persistence of the high number of rescue encounters during this season could be because the agricultural calendar for the region involves an increase in the harvesting, storage and sale of the kharif

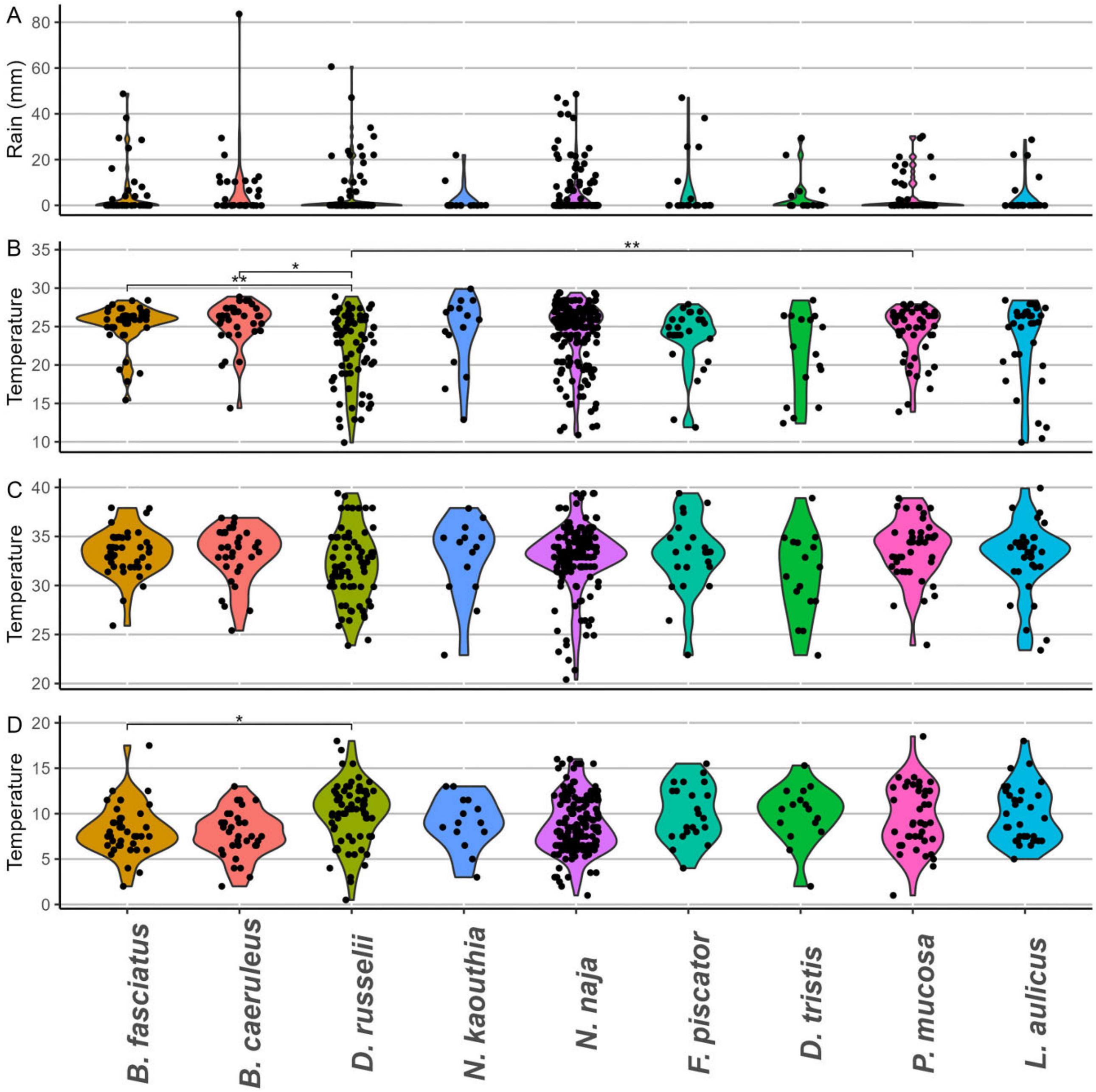


Figure 5. Violin graph showing the distribution of rescue encounters for the selected species in Hooghly District, West Bengal, from July 2020 to October 2022 for each of the climatic factors (A: rain; B: minimum temperature; C: maximum temperature; D: temperature range). The species comparisons that resulted in a significant difference are marked by brackets on top of the respective violin graphs. *p<0.05; **p<0.01.

crops.[35,36] Another finding that differs from previous snakebite epidemiological studies in India is that most of the conflicts did not occur in agricultural fields.[2,37–39] While there still may be snake–human conflict occurring in agricultural fields, the rescue encounters in this study did not reflect this as being the main location of the conflict, perhaps because snake escape behaviour differs in closed anthropomorphic habitat compared with open seminatural habitats such as fields.[40,41] Snakes are also naturally cryptic animals so there is also a chance that they evade human detection and, hence, no rescue encounters occur in such a situation.[42] A future study that could shed more light on such patterns would be to compare data collected via a snake rescue network and snakebite data collected via medical centres in the same region. Rescue encounters could theoretically represent 'mitigated' snake–human conflicts, whereas snakebite data could represent 'unmitigated' snake–human conflicts.

Another notable pattern was the difference in the location of non-venomous rescue encounters (significantly more inside

Table 2. Binomial logistic regression analysis of climate factors as predictors of species involved in rescue encounters (rain: daily rain; rain_prev: rain on the previous day; mintemp: minimum temperature; maxtemp: maximum temperature)

		Estimate (β)	SE	z-value	p-value	AUC
B. fasciatus	(Intercept)	−5.488	1.815	−3.023	0.0025**	0.6772
	rain	−0.002	0.014	−0.1777	0.859	
	rain_prev	0.018	0.009	1.9613	0.0498*	
	maxtemp	−0.017	0.074	−0.2292	0.8187	
	mintemp	0.131	0.064	2.0408	0.0413*	
B. caeruleus	(Intercept)	−4.878	1.991	−2.4506	0.0143*	0.6843
	rain	0.006	0.012	0.5434	0.5868	
	rain_prev	0.005	0.012	0.4195	0.6748	
	maxtemp	−0.097	0.081	−1.2035	0.2288	
	mintemp	0.208	0.072	2.8771	0.0040**	
D. russelii	(Intercept)	−2.598	1.088	−2.3888	0.0169*	0.572
	rain	0.01	0.011	0.8881	0.3745	
	rain_prev	0.012	0.011	1.0932	0.2743	
	maxtemp	0.047	0.054	0.8687	0.385	
	mintemp	−0.05	0.046	−1.0866	0.2772	
N. kaouthia	(Intercept)	−4.166	2.41	−1.7284	0.0839	0.6205
	rain	−0.017	0.043	−0.4062	0.6846	
	rain_prev	−0.053	0.058	−0.9125	0.3615	
	maxtemp	−0.065	0.115	−0.5631	0.5734	
	mintemp	0.115	0.096	1.1935	0.2327	
N. naja	(Intercept)	−2.46	0.85	−2.8919	0.0038**	0.5975
	rain	−0.011	0.009	−1.2331	0.2175	
	rain_prev	0.01	0.007	1.5073	0.1317	
	maxtemp	−0.02	0.039	−0.5037	0.6145	
	mintemp	0.079	0.032	2.4575	0.0140*	
F. piscator	(Intercept)	−6.609	2.039	−3.242	0.0012**	0.6291
	rain	0.012	0.015	0.8365	0.4029	
	rain_prev	0.017	0.013	1.3127	0.1893	
	maxtemp	0.176	0.092	1.9069	0.0565	
	mintemp	−0.119	0.076	−1.5642	0.1178	
D. tristis	(Intercept)	−3.092	2.085	−1.4831	0.138	0.6109
	rain	−0.001	0.024	−0.0606	0.9517	
	rain_prev	0.021	0.019	1.1037	0.2697	
	maxtemp	0.023	0.108	0.2141	0.8305	
	mintemp	−0.057	0.09	−0.6336	0.5263	
P. mucosa	(Intercept)	−5.907	1.568	−3.7659	0.0002***	0.6225
	rain	−0.02	0.022	−0.9146	0.3604	
	rain_prev	0.007	0.014	0.5189	0.6038	
	maxtemp	0.069	0.069	0.9983	0.3181	
	mintemp	0.046	0.059	0.7835	0.4333	
L. aulicus	(Intercept)	−4.965	1.657	−2.9967	0.0027**	0.5833
	rain	−0.02	0.026	−0.7762	0.4377	
	rain_prev	0.012	0.015	0.856	0.392	
	maxtemp	0.107	0.078	1.3615	0.1734	
	mintemp	−0.067	0.064	−1.0511	0.2932	

*p<0.05, **p<0.01, ***p<0.001.

Table 3. Frequency and time of rescue encounters by specific species (early morning: 00:00–05:59 h; late morning: 06:00–11:59 h; afternoon: 12:00–17:59 h; evening: 18:00–23:59 h)

Species	Early morning	Late morning	Afternoon	Evening
B. fasciatus	2	12	3	25
B. caeruleus	0	5	3	30
D. russelii	0	18	29	31
N. kaouthia	0	7	5	5
N. naja	5	55	65	65
F. piscator	1	5	4	18
D. tristis	1	6	8	2
P. mucosa	0	13	23	12
L. aulicus	3	3	8	23

than outside the built-up sites) compared with venomous rescue encounters (an almost even spread across the inside and outside of built-up sites). This was also reflected in individual sites, where four out of the six sites that showed significantly more venomous than non-venomous encounters were inside built-up sites. In addition, the two 'outside' sites that also had significant differences (backyard/front garden and water body) are sites that are frequently attached to or in close vicinity to 'inside' sites. This could indicate that local residents might know that the species is harmless, but prefer not to have it inside their houses, shops and so on, where the chances of a negative conclusion to the conflict are increased with the residents or with domesticated animals such as poultry.

The study also showed the influence of climate variables on the rescue encounters. Surprisingly, rain on the day did not cause any changes in the number of encounters, but instead, the combination of the consecutive days had more of an influence. Thus, while previous studies have shown an increase in snake activity during rainy seasons, our result instead highlights that this activity may not be consistent throughout that time period,[3,24,43] but varies based on changes in daily precipitation. Another possible reason is that changes in human activities during rainy days might also influence the frequency of such encounters. Among the venomous species, *D. russelii* rescue encounters occurred at a wider range of temperatures, especially when compared with the two *Bungarus* species, whose rescue encounters occurred during relatively warmer temperatures. This was also seen in the models where *B. fasciatus*, *B. caeruleus* and *N. naja* rescue encounters were positively correlated to the daily minimum temperatures. There were very few encounters involving *N. kaouthia* and hence no comparisons could be made. The AUC scores for all the models indicate that they only have moderate predictive power. This could potentially be due to the low sample sizes or also because rescues need a human to come into conflict with a snake and then call for the rescue. This means that while the patterns observed are partially due to the snake's activity patterns, human activity patterns also contribute.

Finally, the time periods of the rescue encounters showed that, among the venomous snakes, encounters with both *Bungarus* species occurred mostly in the evening compared with other venomous species that were more evenly spread (excluding early morning). These species, like most *Bungarus*, are nocturnally active snakes,[44,45] and it has been well documented that bites by *B. caerueleus* frequently involve sleeping victims.[46,47]

There are obvious limitations to this study. A snake rescue encounter requires a member of the public to see a snake, call the rescue network and finally have the rescuer capture the snake present. For this reason, a number of potential snake–human conflicts during the study would not have been recorded if a snake was seen but no call to the rescue network was made, or if the snake had escaped by the time a rescuer arrived. Given that the study spans 28 mo, collecting data over a much longer period can allow for more long-term trends in seasonality to be assessed. Another limitation may be the fact that a snake rescue encounter may be affected by human social factors, given that such encounters are not solely based on the ecology of the snakes. Hence, such data can be given further context when there are also socioeconomic data and accurate snakebite hospital data from the same region. The combination of such datasets will help provide a clear picture of regionally specific human–snake conflict.

In conclusion, this study showed that there were more rescue encounters for venomous species in the Hooghly district, with *Naja naja* being the most rescued species, and that season, location, pattern of rain, temperature and time of day all play important roles. These results highlight the potential of using snake rescue networks to help elucidate the ecology of snake–human conflict at a finer scale. Such data, if combined with epidemiological, socioeconomic and ecological studies, can provide a more holistic understanding of the dynamics of snake–human conflict in a given region. Comparisons of similar rescue data from different regions across India are needed to elucidate how snake–human interactions change with habitats, snake assemblages, agricultural cycles and human cultural and ethnic beliefs and practices.

Supplementary data

Supplementary data are available at *Transactions* online.

Authors' contributions: SK and VS conceived the study and oversaw the data collection; JBO advised on improving the data collection; SK, VS, BD, AK, SD, RK and MTA helped with the data collection and curation; SK, AB and AM contributed to the analysis and interpretation of the data; SK drafted the manuscript; JBO, AB and AM provided critical feedback and edits to the manuscript. All the authors have read and approved the final manuscript.

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